A Review of the Genus Sphaerococcopsis Cockerell, With Descriptions of Two New Species (Homoptera: Coccoidea)[1,2]

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Cockerell (1899) proposed the genus *Sphaerococcopsis* for the unusual Australian coccid previously described as *Sphaerococcus inflatipes* by Maskell (1893). Subsequently, the species was redescribed and figured by Morrison and Morrison (1922). These authors pointed out that Maskell's *S. inflatipes,* variety *simplicior* (Maskell 1896) appeared to be a distinct species but did not redescribe it. They also suggested a possible relationship between the genera *Sphaerococcopsis* and *Lachnodius* Maskell, based on similarities in the first stage larvae, which has been substantiated by recent morphological and biological studies on these genera (Beardsley 1972). The present paper constitutes a taxonomic revision of *Sphaerococcopsis.* A similar review of *Lachnodius* is in preparation.

Holotype specimens of the new species are deposited in the Australian National Collection, C.S.I.R.O., Canberra. Paratypes are in collections of the Waite Institute, Adelaide; the U.S. National Museum, Washington, D.C.; and at the University of Hawaii, Honolulu. The type material of the two Maskell species is located in the Entomology Division, D.S.I.R., Nelson, New Zealand. Lectotypes for each of these species were designated by me in September 1972.

Sphaerococcopsis Cockerell 1899. Proc. Acad. Nat. Sci. Philadelphia 1899, p. 262.

Type species: *Sphaerococcus inflatipes* Maskell.

Recognition characters: Adult female of known species occurring within roughly circular blister-like galls in bark of *Eucalyptus* spp. Body form globular, roughly circular in outline with a circular, oval, or broadly pear-shaped dorsal shield composed partly or entirely of small discrete sclerotic nodules separated by areas of unsclerotized derm. Dorsal shield, at least posteriorly, with a marginal series of enlarged conical spine-like setae; central portion of shield with or without additional conical setae. Eyespots located on or near anterior margin of shield. Venter usually with a pair of weakly sclerotized, inflated lobes between bases of antennae. Antennae short, with six or fewer segments, third segment usually long-

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[2]Field work in Australia was conducted during tenure as a Fulbright-Hays research scholar at the Department of Zoology, La Trobe University, Bundoora, Victoria.

est. Legs abnormal, anterior two pairs reduced; posterior legs conspicuously enlarged with femora, tibiae and tarsi moderately to strongly expanded; tarsal claws broad, usually with a minute denticle on inner face just before tip. Tarsal and tarsal claw digitules well developed, with spatulate apices. Labium one-segmented. Anal ring small to very small, roughly circular, usually invaginated at inner end of a short sclerotic tube; bearing several (4 to 10) ring setae; ring pores present or absent, if present very small, distributed around bases of ring setae. Anal lobes not developed or weakly indicated.

Disc pores present on venter, normally quinquelocular, often with a few quadralocular and trilocular pores intermixed. Small to minute tubular ducts usually present on dorsum and venter, occasionally absent; duct orifices simple, sometimes enclosed by a sclerotic rim; inner apices somewhat expanded, truncate or slightly convex. Dorsum sometimes with small, sclerotized, pit-like, possibly glandular structures. Ventral body setae slender, filiform; setae of dorsal shield slender, often very short, sometimes with slightly spatulate apices.

First instar larvae oval in outline; antennae short, 5-segmented; legs normal but stout. Dorsum with a complete marginal series of stout, conical or peg-like setae. Anal ring circular, with or without setae; anal lobes not developed but position indicated by pair of long slender setae. Dorsal derm bearing small, oval, sclerotic nodules. Dorsum usually with a few small tubular ducts, often with scattered peg-like or conical setae.

Second stage female nearly circular in outline; similar to adult except appendages all greatly reduced, their segmentation indistinct or incomplete; hind legs largest. Dorsal shield weakly sclerotized.

Second stage male oval in outline; with three pairs of normally developed legs; antennae 6-segmented. Dorsum with or without small sclerotic nodules; marginal series of conical or peg-like setae complete, nearly complete, or reduced to a few enlarged setae posteriorly. Anal ring present, bearing several setae; ring pores absent or reduced to a very few around bases of setae. Tubular ducts present, generally numerous on dorsum; disc pores few or absent.

Features which distinguish this genus from all others are: 1) the unusual shield-like dorsum, and 2) the enlarged hind legs of the adult female. The dorsal shield appears to compose the entire true or morphological dorsum. During each stadium its size remains relatively unchanged while the venter expands greatly as the insect grows. Thus, in mature individuals of each instar the venter balloons outward so that the dorsal shield becomes a central disc which occupies the center of the upper surface of the insect. The dorsal shield apparently functions as a plug which closes the dorsal orifice of the blister gall which encloses the insect.

Taxonomic Affinities of Sphaerococcopsis. Morrison and Morrison (1923) called attention to the close similarity between the first instar of *Sphaerococcopsis inflatipes* and those of *Lachnodius* spp. The close rela-

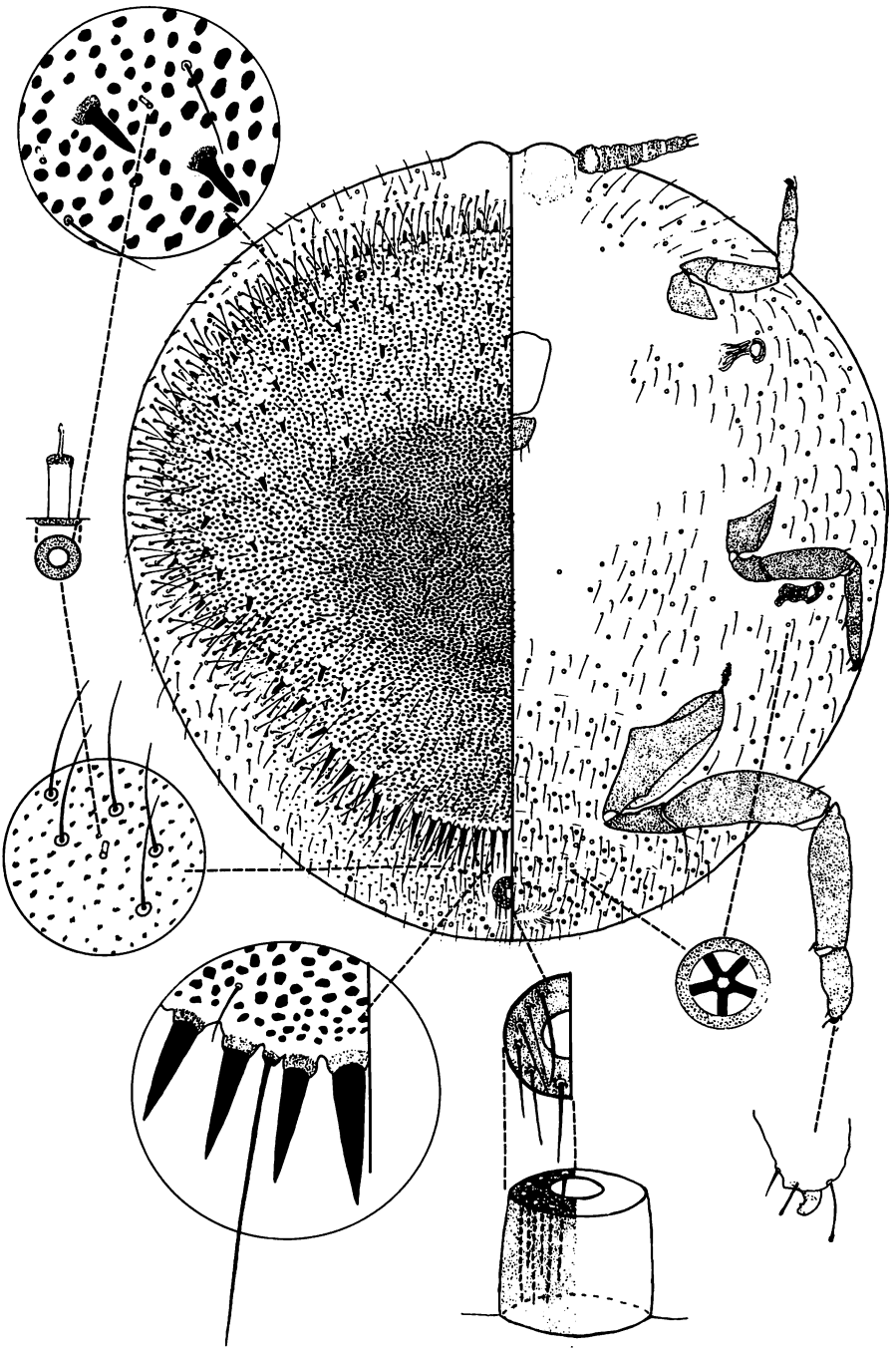

FIG. 1. *Sphaerococcopsis inflatipes* (Maskell); adult female.

tionship between these genera is apparent not only in the first instar, but also from a number of other distinctive morphological and biological characters which they share. These include the following:

(1) Dorsal disc with a peripheral fringe of enlarged setae.
(2) Presence of a pair of large, weakly sclerotized lobes of unknown function on venter of head between antennae.
(3) Anal ring, when poriferous, with pores very small and surrounding bases of ring setae.
(4) Anal ring on the morphological venter in second instar and adult females; no anal cleft present.
(5) Tubular ducts of a distinctive type, different from those of both the Pseudococcidae and the Eriococcidae.
(6) Adult males very similar, with genital capsules like those of the Eriococcidae and with hamulohalteres absent.
(7) Developmental cycle of an unusual type which includes sedentary, usually gall-inhabiting immature stages. Second instar females have reduced, non-functional legs whereas second instar males retain functional legs and leave feeding sites prior to pupation. Males pupate within ovoid, loosely-knit cocoons resembling those of Pseudococcidae. Adult females (third instar) regain at least one pair *(Sphaerococcopsis)* or three pairs *(Lachnodius)* of functional legs.

Key to Known Species of *Sphaerococcopsis;* Adult Females

1. Enlarged marginal fringe setae of dorsal shield relatively few, total around 30 or less, confined to posterior part of shield margin; anterior legs and antennae very small, antennae 2 or 3-segmented; tubular ducts absent ..... *simplicior* (Maskell)
— Enlarged setae forming a continuous fringe on periphery of dorsal shield; antennae and anterior legs larger, antennae normally 5 or 6-segmented; tubular ducts present, at least on dorsal shield 2
2. Dorsal shield with conical setae scattered on submarginal regions of disc in addition to marginal fringe, surrounded by a ring of relatively long body setae; hind tarsal claws often partly retracted into tips of tarsi ..... *inflatipes* (Maskell)
— Dorsal shield without conical setae on disc, not surrounded by a ring of long body setae; hind tarsal claws not retracted 3
3. Dorsal shield with a raised, circular, button-like area of somewhat more heavily sclerotized derm at posterior end; tubular ducts of shield all very small, about 4-5μ diameter ..... *umbilicus* n. sp.
— Dorsal shield without such a button-like raised area; shield with numerous larger tubular ducts, about 7μ diameter, in addition to small ducts ..... *platynotum* n. sp.

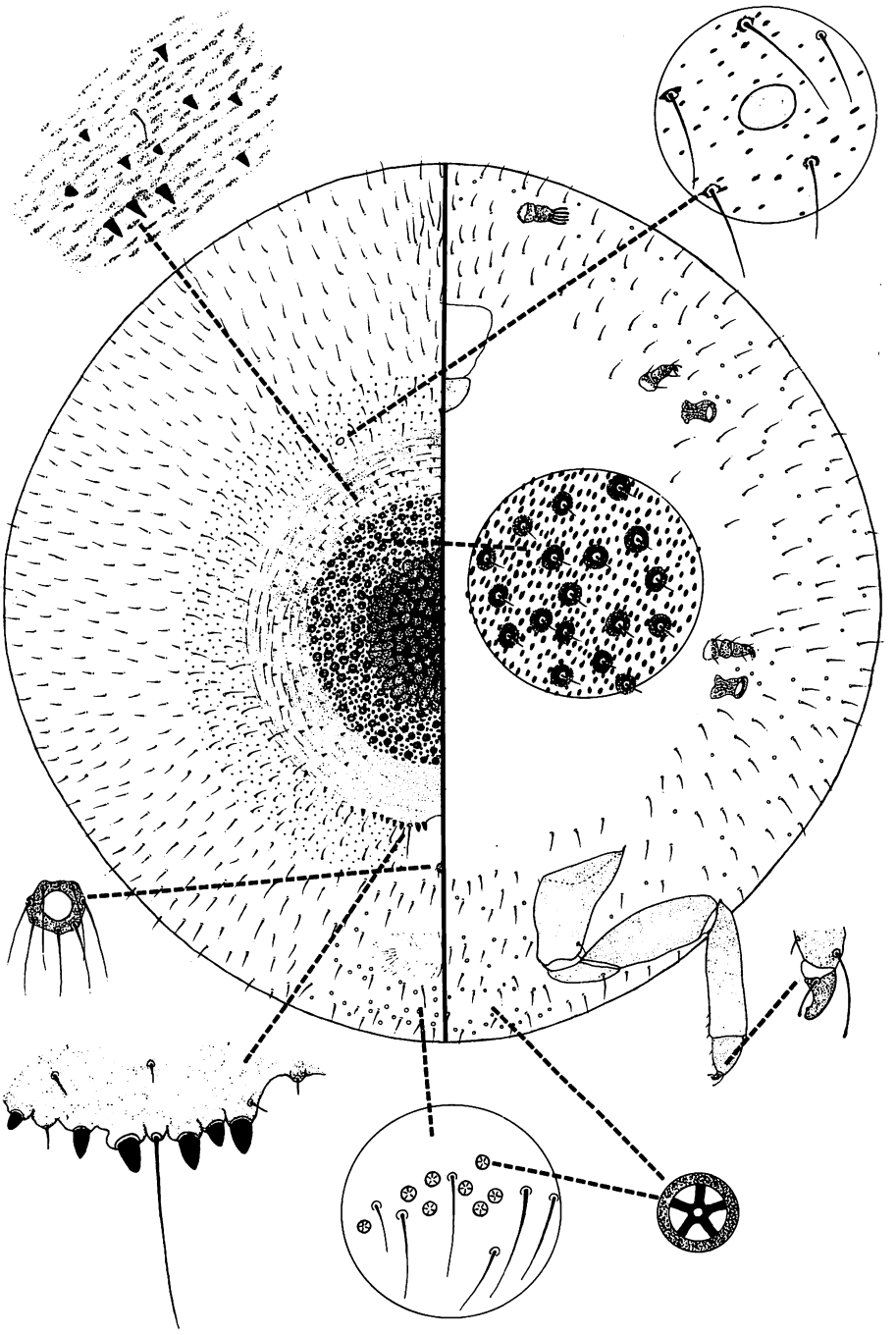

FIG. 2. *Sphaerococcopsis simplicior* (Maskell); adult female.

Sphaerococcopsis inflatipes (Maskell) (Fig. 1).

Sphaerococcus inflatipes Maskell, 1893. Trans. New Zealand Inst. **25:** 238.

Sphaerococcopsis inflatipes, Cockerell, 1899. Proc. Nat. Sci. Philadelphia for 1899, p. 262.

Morrison and Morrison (1922) redescribed this species in detail. Examination of fresh slide preparations from the type lot as well as some recently collected material indicates that a few minor corrections to the Morrisons' redescription are required. The eyespots, which were not found by these workers, are generally discernible in my preparations. In addition to quinquelocular pores, the only gland orifices which were noted by the Morrisons, there are minute tubular ducts with orifices 2-3μ diameter, sparsely distributed on the dorsal shield. The cast skin which the Morrisons described and figured as possibly that of the intermediate stage female, but more probably of the larva, is, as they suspected, the first instar.

Specimens examined, 24: VICTORIA, Myrniong, no date, C. French, on *Eucalyptus* sp. (type lot). Lower Plenty, 21 Nov. 1971, J.W. Beardsley, ex *Eucalyptus viminalis* bark; AUSTRALIAN CAPITAL TERRITORY, Canberra, 26 Aug. 1972, J.W. Beardsley, *Eucalyptus* sp. bark.

Sphaerococcopsis simplicior (Maskell), new status (Fig. 2).

Sphaerococcus inflatipes, var. *simplicior* Maskell, 1896. Trans. New Zealand Inst. **28:** 403.

Sphaerococcopsis inflatipes, var. *simplicior,* Fernald 1903. Mass. Agric. College Bul. **88:** 85.

Adult female: Slide mounted specimens 1.2-2.0 mm long; circular in outline. Dorsal shield 0.7-0.8 mm wide, nearly circular or slightly wider than long, with a shallow posterior emargination immediately above anal ring; center of disc usually densely sclerotized, individual nodules more or less coalesced, becoming enlarged to form lobular, sclerotic papillae in older specimens; intermediate portion of disc with nodules more distinct, with scattered, fine, short setae 10-12μ long borne on small, circular, sclerotized papillae; marginal third of disc more uniformly sclerotized, nodules less distinct, tending to coalesce, derm bearing several irregular, short, concentric, arcuate series of small sclerotic spines 5-10μ long, and a few, scattered, fine setae 12-18μ long; peripheral derm surrounding shield with numerous, small, weakly sclerotized nodules. Marginal fringe of dorsal shield reduced, enlarged marginal setae confined to posterior edge on either side of apical emargination, consisting of 7 to 12 apically rounded conical setae on each side; innermost fringe setae largest, usually 12-14μ long; anterior conical setae generally smaller; a single elongate, slender seta, about 75μ long on each side of shield margin laterad of second or third conical seta. Eyespots located anteriorly a short distance beyond outer margin of shield.

Antennae very short, around 75μ long, with 2 or 3 incompletely separated segments. Forelegs about 75μ long, usually with 3 incompletely separated segments discernible; middle legs similar, about 100μ long. Hind legs with all segments well defined, 0.7-0.9 mm long; coxae elongate, tibiae and tarsi strongly expanded. Anal ring very small, 20-30μ diameter; usually with 4-8 small ring setae around 15-20μ long; without discernible pores. Venter with 90-130 quinquelocular disc pores on posterior abdominal segments around gonopore; a few additional disc pores anteriorly near spiracles and scattered in a sparse submarginal band around anterior portion of body; tubular ducts apparently absent. Body setae, except for dorsal shield, elongate, slender, 40-70μ long. Interantennal lobes not developed.

Specimens examined, 20: VICTORIA; Melbourne, 1895, C. French, ex *Eucalyptus viminalis* (type lot); Bundoora, Sept.-Dec. 1971, J.W. Beardsley, ex bark of *Eucalyptus camaldulensis*. QUEENSLAND; Cunningham's Gap, March 1972, J.W. Beardsley, ex bark of *Eucalyptus* sp.

In *S. simplicior* the dorsal shield is more contracted and heavily sclerotized than in the other known species. The shield seems to be composed of three more or less distinct regions: a roughly circular central area bearing a mass of large, closely packed, strongly sclerotized papillae; an intermediate ring of less sclerotic derm characterized by discretely separate nodules and small setigerous papillae; and an outer ring of more evenly sclerotized derm bearing sclerotic spines. In some, presumably older, specimens the highly sclerotic central area is enlarged, largely obliterating the intermediate ring, and it appears that the strongly developed sclerotic papillae of the central area may develop from the smaller type of papillae of the intermediate ring as the insect ages. In a few, presumably young, adult females the central sclerotic area is hardly or not at all developed. A cross section through the dorsal shield of a mature female of this species shows that the central sclerotic portion forms a raised boss and the outer and intermediate ring areas form a surrounding trough.

Sphaerococcopsis umbilicus, n. sp. (Fig. 3).

Adult female: Slide-mounted specimens 1.2-1.6 mm long, nearly circular in outline. Dorsal shield broadly pear-shaped, 0.8-1.0 mm long, without a posterior emargination. Derm of shield beset with numerous small sclerotic nodules, these smaller and more widely separated on anterior portion, larger and closer together posteriorly; shallow sclerotized oval pit-like depressions, possibly glandular in nature, scattered among nodules. Posterior part of shield a roughly circular, raised, umbilicus-like area often with a depressed center, about 350μ diameter. Shield with sparsely scattered small lanceolate setae 8-9μ long, smaller acute setae 4-6μ long, and very small tubular ducts with narrow sclerotized rims, 4-5μ diameter. Marginal fringe of shield complete, containing about 114 conical setae; longest of these at posterior end, around 20-25μ long;

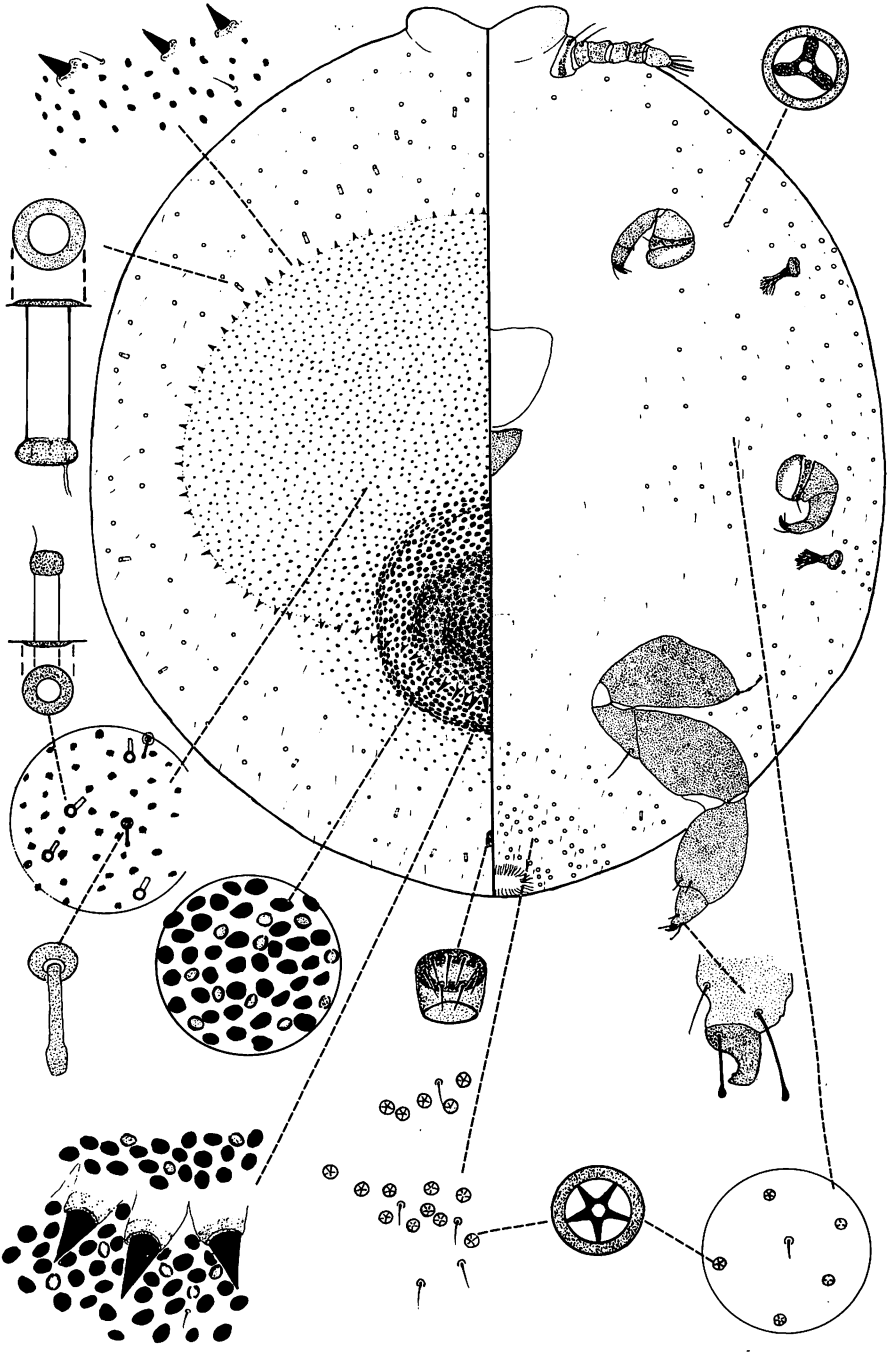

FIG. 3. *Sphaerococcopsis umbilicus*, new species; adult female.

anterior conical setae smaller but of variable size, mostly 8-14μ long. Eyespots on anterior edge of dorsal shield.

Antennae short, about 175μ long, usually 6-segmented, occasionally 5-segmented. Fore and middle legs small, segmentation usually discernible but coxae mostly membranous; forelegs about 175μ long; tarsal claw denticles minute, sometimes not discernible. Hind legs with coxae moderately elongate; tibiae and tarsi strongly expanded; total length 0.65-0.75 mm. Anal ring very small, 15-22μ diameter; invaginated at inner end of a short, sclerotized tube; ring with 6-8 short setae; without discernible pores; anal orifice about 10μ diameter. Venter of abdomen with numerous quinquelocular (occasionally quadralocular or trilocular), disc pores distributed in segmental bands on prevulvar abdominal segments, and scattered in submarginal areas anteriorly. A few small tubular ducts, 4-5μ diameter, scattered on submarginal areas of venter. Ventral setae short, fine, mostly 6-12μ long in lateral areas; a few 15-25 μ long on posterior abdominal segments and head.

Described from 12 specimens. Holotype and paratype: VICTORIA, mallee scrub area west of Horsham, 24 April 1972, J.W. Beardsley, ex bark of *Eucalyptus gracilis*. Ten paratypes: VICTORIA, near Heathcote, 15 June 1972, J.W. Beardsley, ex bark of *Eucalyptus microcarpa*.

This species and the following, *S. platynotum* n. sp., appear to be closely related. In addition to the characters utilized in the key, *S. umbilicus* differs from the latter in having somewhat smaller antennae and legs, a smaller anal ring and slightly smaller conical fringe setae on anterior margin of shield.

Sphaerococcopsis platynotum n. sp. (Fig. 4).

Adult female: Slide-mounted specimens 1.2-1.4 mm long; circular or broadly oval in outline. Dorsal shield broadly pear-shaped, about 0.95 mm wide, flat, without a posterior emargination. Derm of shield bearing numerous small, sclerotic nodules densely, evenly distributed over surface; sparsely scattered small digitiform or slightly lanceolate setae 8-10μ long; and scattered small tubular ducts with narrow sclerotic rims; the latter of two sizes, larger 7-8μ diameter, smaller 3-4μ diameter; larger ducts most numerous in central and posterior portions of shield. Eyespots on anterior margin of shield. Marginal fringe of shield containing around 120 conical setae; largest conical setae at posterior end of disc about 22-25μ long; anterior conical setae smaller, of variable size, mostly 10-20 μ long.

Antennae moderately short, around 200-240μ long, 5- or 6-segmented. Fore and middle legs small, all segments distinct; forelegs about 200-220μ long; tarsal claws with a minute denticle. Hind legs with coxae elongate, tibiae and tarsi strongly expanded; total length 0.8-0.9 mm. Anal ring moderately small, around 35μ diameter; invaginated at inner end of a short sclerotized tube; ring bearing around 8 short setae 18-25

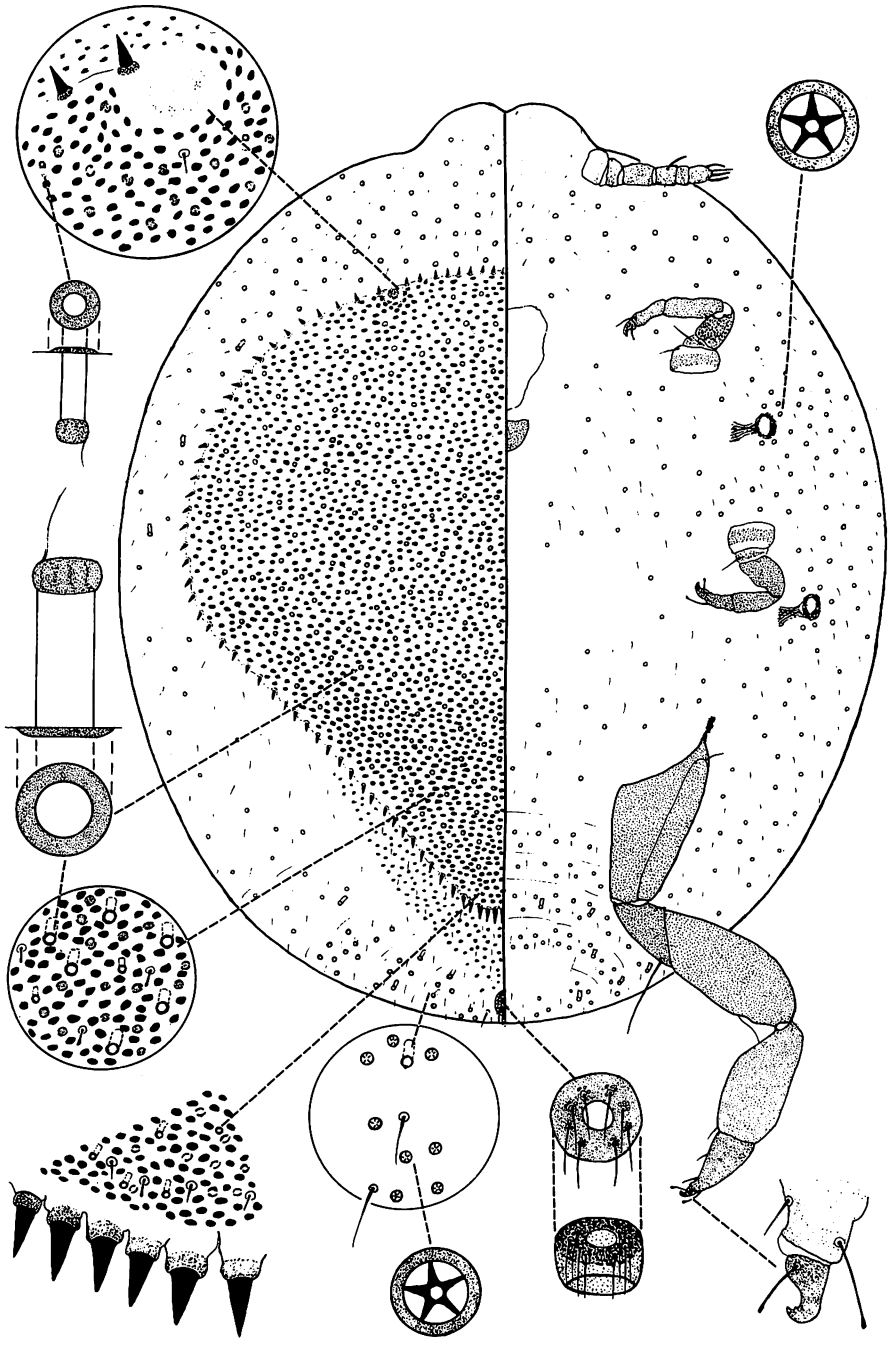

FIG. 4. *Sphaerococcopsis platynotum*, new species; adult female.

μ long; with a very few minute pores around bases of some ring setae; anal opening about 14μ diameter. Venter of abdomen with numerous quinquelocular disc pores arranged in segmental bands on 4 prevulvar segments, and scattered over submarginal areas of body anteriorly; a few such pores also on midventral areas of thorax and anterior abdominal segments. A few small tubular ducts 6-7μ diameter scattered on venter of posterior abdominal segments, and near margin of dorsal shield anteriorly. Ventral setae mostly short, fine, 10-15μ long; a few 20-34μ long on posterior abdominal segments and head.

Described from 14 specimens. Holotype and 2 paratypes: VICTORIA, Lower Plenty, 14 Nov. 1971, J.W. Beardsley, ex bark of *Eucalyptus melliodora;* 11 paratypes, same locality, collector and host, 1 Jan. 1972. Additional specimens examined: SOUTH AUSTRALIA, Erskine, 8 Nov. 1955, D.C. Swan, ex. pustules on bark of *Eucalyptus* sp. (8 specimens).

The South Australian specimens are considerably smaller than the type material but agree quite well otherwise.

This species is closely related to *S. umbilicus* n. sp., described earlier in this paper. See the discussion following the description of the latter for consideration of differences between these two species.

Biology of Sphaerococcopsis spp. All four species of *Sphaerococcopsis* inhabit similar blister-like galls on the bark of twigs, limbs and trunks of *Eucalyptus.* In their diagnosis of the genus Morrison and Morrison (1923) repeated Maskell's earlier misconception when they referred to these insects as secreting a "firm compact waxy test, almost horny externally, with spongy inner layer and median dorsal opening . . . ." The "test" so described is, in fact, a gall composed entirely of plant tissue (Fig. 5). The galls of the four species are essentially similar and when mature consist of a blister-like swelling covering a shallow, smooth-walled circular cavity beneath a thin layer of bark. Each gall bears a small, circular opening, approximately 0.5 mm diameter, at the center of the convex blister.

Observations of *Sphaerococcopsis simplicior* made at Bundoora, Victoria during 1971-72 indicated that this species probably has a single generation per year. The crawlers hatching from eggs deposited during November and December leave the galls by means of the dorsal orifice and settle on young bark tissue on twigs and branches. During June and July partly to fully grown first instar *S. simplicior* were found completely enclosed within small pustules of succulent host tissues. The second instars appeared during August and September. At that time the galls had increased in size and had developed the dorsal orifice which the insects kept sealed by means of the first stage exuviae plus waxy secretions. The second instars exhibit pronounced sexual dimorphism. The males are elongate-oval in shape and retain three pairs of functional legs (Fig. 6), whereas females are globular, circular in outline, and have legs reduced to non-functional vestiges. Males finished feeding and deserted their galls

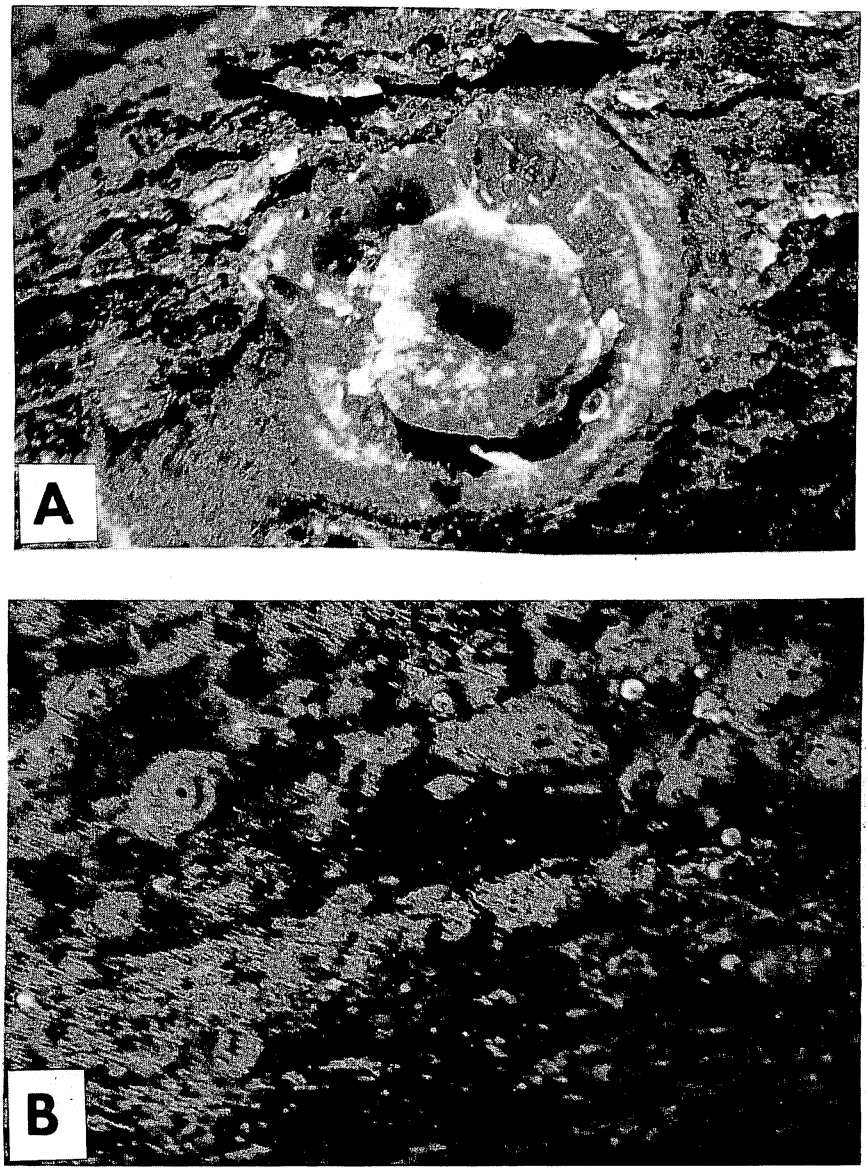

FIG. 5. A. *Sphaerococcopsis simplicior* (Maskell), blister gall opened to show adult female. B. *S. simplicior* blister galls on bark of *Eucalyptus camaldulensis*.

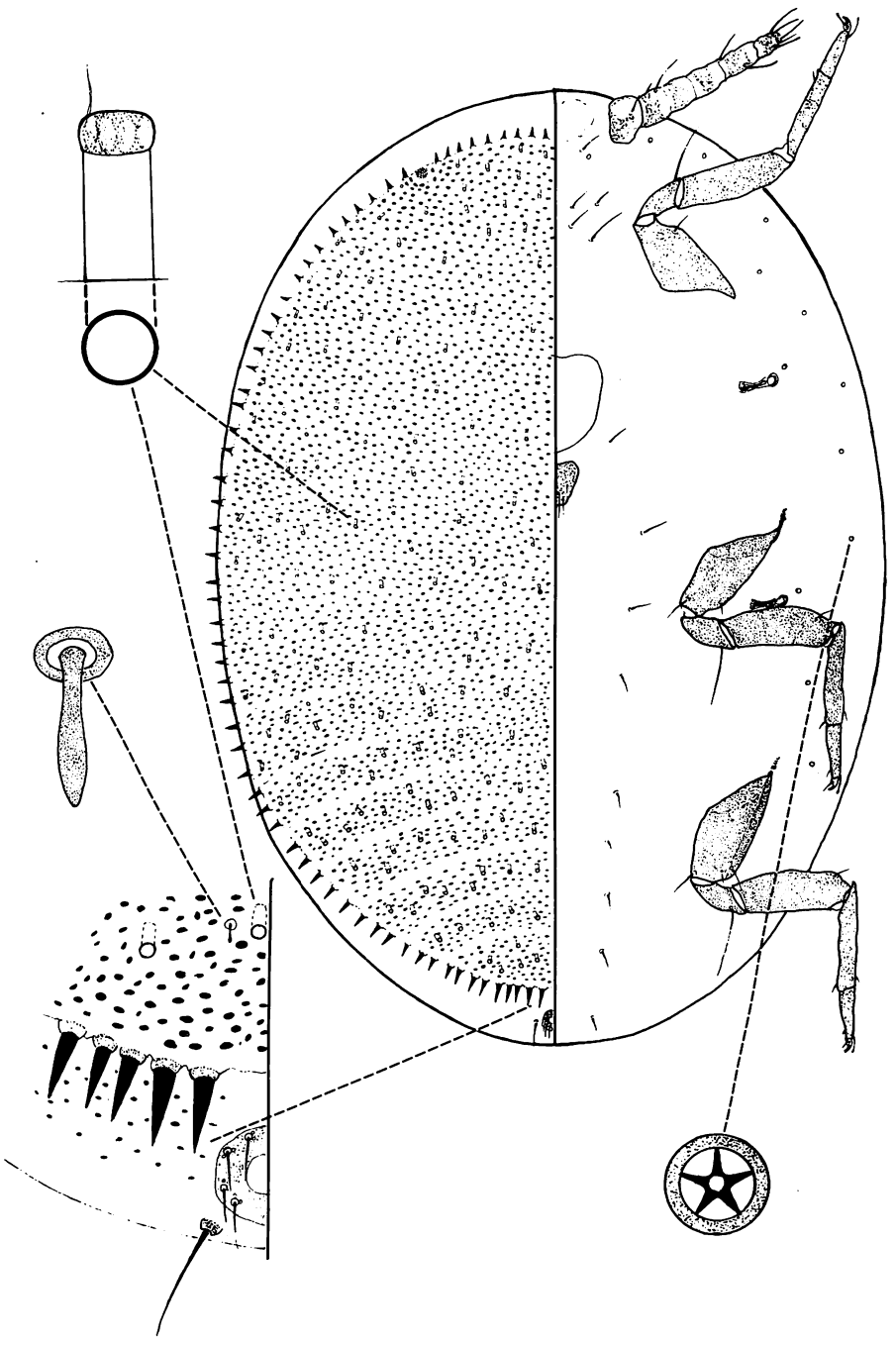

FIG. 6. *Sphaerococcopsis platynotum*, new species; second instar male.

during September. At this time prepupal males formed loose ovoid cocoons of wax filaments under loose bark, or in crevices of various sorts. Adult males of this species were not obtained, but the male developmental cycle was followed to completion in *S. umbilicus* n. sp. Prepupul males of the latter were collected during April. These formed cocoons and pupated in the laboratory, the winged adult males emerging during June. Presumably, this was an abnormally early emergence resulting from exposure to indoor temperatures. In the case of *S. simplicior;* adult females first appeared in October, and oviposition occurred during November and December. Thus, there are three instars in the female developmental cycle, and four in the male cycle.

The function of the greatly enlarged hind legs, characteristic of adult female *Sphaerococcopsis,* is unknown. Species of the genus *Opisthoscelis* Signoret (also gall-formers on *Eucalyptus*) are similar in this regard. Perhaps in these genera the hind legs function during mating, possibly serving to clasp and guide the male abdomen prior to copulation. No observation on mating in either of these genera have been reported, but the size of the adult males suggests that probably they are unable to enter completely into the female galls, and therefore, copulation may necessitate extension of the male abdomen through the gall orifice.

Several genera of Coccoidea, in addition to *Sphaerococcopsis,* produce galls on *Eucalyptus* in Australia (e.g.: *Apiomorpha* Rübsaamen, *Ascelis* Schrader, *Lachnodius* Maskell and *Opisthoscelis* Signoret). None of these produce blister galls of the type which is characteristic of *Sphaerococcopsis.* However, one species described in the catch-all genus *Sphaerococcus* Maskell, *S. elevans* (Maskell, 1895) does inhabit blister galls of a similar type. This insect has been redescribed as the type species of the new genus *Floracoccus* (Beardsley 1974). Despite the similarity between their galls, *Floracoccus* may not be closely related to *Sphaerococcopsis.*

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